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MEETING THE FOREST PROBLEMS OF THE LAKE STATES

Annual Investigative Report
Lake States Forest Experiment Station
Forest Service, U. S. Department of Agriculture

Maintained in cooperation with
University of Minnesota
at University Farm, St. Paul, Minn.

January 1939

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EXPERIMENT STATION



To insure prompt seed dissemination from jack pine cones, it is necessary that the slash be lopped and scattered close to the ground. Note how degree of opening varies inversely with the distance from the ground. (See page 15.)

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Publications

January 1939

MEETING THE FOREST PROBLEMS OF THE LAKE STATES

NEED FOR NEW ORIENTATION

During the past year there have become evident several new trends which are bound to affect the course of forest research.

The reorganization of the Department of Agriculture alone involves important shifting of activities. Although it has not yet brought about any actual changes in the work of the Station, it has already raised a number of vital questions. If the objectives of reorganization are carried out, as they doubtless will be, they are bound to modify the work of the Station in farm forestry, land use, flood control surveys, and forest influences.

The creation of state and county land-use-planning committees provides new channels through which research can and must work. This calls for close cooperation between the Station, the state agricultural experiment stations, and the various other bureaus in the Department of Agriculture, notably the Extension Service, Bureau of Agricultural Economics, Soil Conservation Service, the Farm Security Administration, and the Agricultural Adjustment Administration. It is only from close contact with action and planning agencies that research obtains its direction and inspiration.

In land-use studies the Station has cooperated with the Northern Lake States Regional Planning Committee in the preparation of a special report for the National Resources Committee. It has aided the Minnesota Interim Commission in the study of tax delinquency and has acted as leader of flood control surveys handled jointly by the Soil Conservation Service, Bureau of Agricultural Economics, and Forest Service.

The Joint Congressional Committee investigating forestry conditions was the stimulus for the preparation of several reports from Forest Survey data during 1938. The Station worked, with the help of the Regional Forester, in preparing a report for the Chief of the Forest Service. It also assisted representatives of the Northern Pine Manufacturers Association and the Hemlock-Hardwood Association to analyze conditions in two of the major lumbering areas of the region.

The creation of all these special committees has demanded a great deal of so-called "extracurricular" work from the Station which was not originally anticipated and which was not provided for financially. Yet the participation in all these committees is vital because,

as has happened on several occasions, the Station was the only organization to have the basic information required. Although the Station does not receive public credit for information put out in this way, as it does in the case of formal publication, yet there is no gainsaying that the most profitable use is made of research results thus disseminated. Moreover, the Station benefits materially by being able to keep abreast of new developments by reason of such participation.

Farm forestry has been given a considerable boost in the Lake States during the past year as a result of the interest of the Extension Service, the AAA officials, and interested individuals. The Station has offered the full facilities of its research staff to further these programs and is making plans for additional studies to assist the work of the action bureaus.

The transfer of quarters from the Old Dairy Building, University Farm, St. Paul, to the new forestry building (Green Hall) on the same campus, which was accomplished in June 1938, brings the Station in closer contact with the University's Division of Forestry and helps to cement the already fine cooperative relations with that institution. The Station is now provided with excellent office and laboratory space and, for the first time since 1934, has its whole organization under one roof.

Cooperation with Region 9 of the Federal Forest Service was extended and improved. However, during 1938 a major change in the policy for handling the CCC was put into effect. The decision to confine the work of the camps strictly to "performance" and to avoid participation in planning or research activities except insofar as they directly involve the day-to-day jobs of the camps, considerably curtailed the work of the Station, especially the Forest Survey and fire studies. However, the financial assistance of the CCC for certain reforestation activities was continued. It is an unfortunate situation that makes it necessary to finance from such emergency appropriations a major part of the Station effort that goes into reforestation.

The new immediate problems confronting Congress, such as unemployment relief, soil conservation work, and control of agricultural production, make it increasingly more difficult for our legislators to give attention to research activities, especially if they are not of a spectacular nature; yet they are essential to a realistic solution of our problems.

In view of all these new circumstances, it is essential that the Forest Experiment Station should "rethink" many of the activities in which it is engaged and the organization of its work, in order that it may adjust itself to these new trends.

It is in this new light, therefore, that the Station discusses its accomplishments of last year and presents its plans for the future.

FOREST ECONOMICS

NEW PUBLIC DOMAIN

Studies of the causes, extent, and trends of tax delinquency, and its effect on ownership and local government finance, have developed a number of remedial legislative recommendations. These, together with recommendations presented by other state and federal agencies and by students of government and taxation, form a very comprehensive and definite program for legislative action. Most of these recommendations are included in the report of the Minnesota Interim Legislative Commission on Forestry and Tax-Delinquent Lands, and in reports by the Minnesota State Planning Board, the Northern Lake States Regional Committee, and others. In Minnesota, bills are now being drafted for enactment of several of the proposals into law. Until the legislature has acted on these matters, very little of value can be added by further studies in these fields. The "law of diminishing returns" already has begun to operate. This phase of the New Public Domain project, therefore, may be considered as practically completed.

Various published reports emanating from this Station discuss in considerable detail the information and recommendations developed under this project. The outstanding points revealed by the studies may be summarized briefly:

1. Sweeping Changes in Land Ownership

As a result of tax delinquency and inability of private land-owners to develop the lands productively, there has been a tremendous growth in public ownership. In 1929, there were scarcely 6 million acres of public lands--federal, state, and county--in the three states. Today, 10 years later, there are more than 20 million acres of forest land directly under public control. The gross acreage of national forests alone has increased from $2\frac{1}{2}$ million acres to 12,198,000 acres. Minnesota has state conservation units with a total area of 7 million acres, and in Wisconsin the gross area of county forests is more than 5 million acres. These large changes in ownership are indicative of an abrupt shift in the trend of economic development in the forest region.

2. Planless Expansion of Agriculture Is at an End

Through rural zoning, land classification, and settler relocation, the use of land for agriculture is being more and more directed and confined to the most productive lands in settled districts.

3. Use of Land for Conservation Purposes Growing

Some 40 percent of the total forest area is now in public ownership and is generally accepted as suitable only for conservation purposes. This acreage, as time goes on, is bound to increase still further.

4. Local Units of Government Practically Bankrupt

The shrunken tax base, indebtedness incurred in earlier "boom" times, and tax delinquency have made it impossible for local governments to carry on essential public services from local tax revenues. A program of grants-in-aid is vital.

5. Large Acreage of Forest Land Publicly Owned

The large acreage of publicly owned forest land makes the public the largest single agency responsible for the rehabilitation of the region. This involves large expenditures by public agencies for the aggressive development of the resources under their control, and to provide employment during this period of reconstruction.

6. The Next Phase

The problems of local-government finance and organization in the cut-over counties still offer, of course, a wide field for study and investigation. Although these problems have a direct bearing on the use of forest land in the northern counties, they lie in the field of political science which is chiefly outside the forester's province and where many other agencies better equipped to handle the problem are active. With the coming action by the State on questions of the ownership and control of tax-forfeited lands, there is no need for further study by the Station of the legal and financial aspects of delinquency. There still remains, however, the larger problem of finding ways and means of converting forfeited lands to productive uses. It is toward these problems that the work will be directed during the coming year. Emphasis will be placed on problems of organizing forfeited and other public lands for permanent forest production in a manner that will do most to stabilize employment and afford work to the largest number of settlers.

FOREST SURVEY

All field work for the Forest Survey has been completed. Most of the compilation is also done. The project is now in the stage of report writing and interpretation. There are to be three separate reports for the three Lake States and an integrated report for the region as a whole.

In evaluating the results of the Survey obtained during the past year and in outlining the plans for the future, it is of interest to discuss the social and economic implications and the new trends which it has revealed.

1. Forest Statistics Interpreted Too Optimistically

It is the universal experience that no matter how one may qualify statistical data they will be differently interpreted by different people depending upon their point of view. The general statement that there are 57 billion board feet of saw timber in the Lake States has been interpreted

by some to mean that there are still abundant supplies of timber on hand for the lumber industry. What has been overlooked is that 44 percent of this total volume consists of scattered timber on cut-over land in stands of less than 2,000 board feet per acre. Such stands usually cannot be logged economically. The estimate also includes trees down to 9 inches while the commercial limit for hardwoods is about 13 inches. The volume is expressed in International scale, which is 15 percent higher than the commercial Scribner log rule. The volume estimate includes certain poor species, such as black ash, balm of Gilead, and red maple, which have little commercial value, while the lumber industry is based largely on pine, hemlock, hard maple, and yellow birch. If all these factors are taken into account the actual volume of accessible and loggable timber is found to be quite limited.

The preliminary computations indicated an annual growth of about 1,850 million board feet as against 1,279 million feet of lumber production. At first this seemed a most hopeful sign. The depletion phase of the survey, however, has shown that large quantities of saw timber are being cut for fuel wood, fence posts, ties, pulpwood, distillation wood, veneer, etc. If these and normal fire and other losses be added to the lumber production, the total depletion of saw timber for all purposes averages 2,348 million board feet, or one-fourth more than the annual growth.

2. Growth and Depletion Alone Do Not Tell the Story

Growing stock too heavy

Mere balancing current growth and depletion is not necessarily evidence of a healthy state of the forest, nor is the annual growth a measure of the amount that should be cut each year. In a forest which is in a run-down condition, the growth must exceed the annual cut if the area is not to remain in a permanently depleted condition. On the other hand, in a virgin forest where there is a large accumulation of old trees and the growth is small or nil, the cut for many years may far exceed the growth without detriment and sometimes with positive improvement to the forest itself. The emphasis which foresters have placed in the past upon the desirability of balancing growth and cut becomes meaningless for the run-down forests of the Lake States.

Growing stock too light

The Forest Survey is now estimating the actual yield capacity of the forest. This is being done not strictly in conformity with the annual growth, but is based upon the density and age-class distribution of the growing stock. In the northern hardwoods of the Upper Peninsula, the allowable cut will be greater than the annual growth and such cuttings should stimulate the growth of the stands. In the young understocked forests, the allowable cut will be smaller than the growth. The total allowable cut for the three States will undoubtedly be somewhat less than the current annual growth.

3. Survey Data Have Bearing upon Public Control over Private Operations

The critical problems in the Lake States are primarily on private lands which include three-fifths of the forest area and four-fifths

of the saw-timber volume. It is estimated that 94 percent of the saw timber cut in 1936 was from private forests. The statistics gathered on ownership show little evidence of intention, or for that matter the practicability, of sustained-yield management by private owners under existing conditions. The studies bring out the complexity of the situation and emphasize the necessity of having a thorough understanding of the problem before remedies are undertaken. Doubtless public ownership or some form of public regulation will be called for. The wide variety of types and conditions and the difficult economic situation, however, preclude adoption of drastic and arbitrary measures.

4. Need for Reorganizing Research in Forest Economics

In no other phase of research activity is there greater need for new orientation than in forest economics. The reasons for this have been made clear elsewhere in this report. The Station proposes the following general reorganization of its investigations in forest economics to fit them more closely to the needs of the present time:

Field Division of Forest Economics

1. Forest Survey

- a. Resource statistics.--A matter of keeping up to date and improving the forest-survey statistics on areas, volumes, growth, and depletion.
- b. Production statistics.--Cooperation with the Census Bureau and Trade Associations in collection of local statistics on annual production of lumber and other forest products.
- c. Price statistics.--Collection and dissemination of local stumpage and log price information for the use of farmers and small timber cutters. Probably in cooperation with extension foresters.
- d. Ownership statistics.--Maintaining an up-to-date record of status, public forests, principal private owners, and others. Analyzing trends.

2. Forest Products

- a. Marketing of forest products.--Primarily to seek outlets for inferior forest products from farms and commercial forests. Will involve intensive surveys of requirements of industries in certain areas. Outlets for by-products will also be considered.

3. Contribution of Public Forests

- a. Costs and returns from forest management on public forests.--Analysis of unit costs of various activities on experimental

forests, national and state forests, and forecasts of income. Includes consideration of contribution in lieu of taxes. To be handled in cooperation with administrative agencies and the forest management division at the Station.

- b. New Public Domain.--Investigation of measures needed to permit organization of tax-reverted and other public forest lands into self-sustaining units, and thus make them contribute more to local employment and community maintenance.

4. Economics of Private Forestry

- a. Financial aspects of private forestry.--To determine the economic practicability of forestry on private lands in the Lake States.
- b. Costs and returns from management of farm woods.--Survey of cases of good management in the Lake States and observations on demonstration areas established by the extension foresters. Also to experiment in cooperative marketing and other forms of organization to increase cash income from sale of farm-forest products. Major consideration will be given to woodlands within and adjacent to public forests.

THE FARM WOODLAND PROBLEM

1. Station Guides Increased Public Interest in Farm Woodlands

With the general awakened interest in the welfare of the farmer, extension people, county land-use committees, and others are beginning to devote a great deal of attention to the farm woodland problem, and the results of the Station's work in this field are received with great interest.

The past year has seen the completion by the Station of case studies and analyses of the farm-forest situation in seven typical woodland areas of the region. These studies furnished a basis for the cooperation with action agencies upon whom the Station must depend for the translation of its findings into programs of work. For instance, the results of our studies in the Littlefork area of northern Minnesota, a part-time farming area, (1) served as a pattern for setting up forest-farm working circles in which State forests will furnish the winter employment essential to the stability of the region, and (2) spurred the proposal of legislation to permit small timber sales to individual settlers. Also as a result of recommendations based on our studies in the Yuba area of southwestern Wisconsin, State agencies are now fostering a small experimental enterprise in the cooperative management and marketing of farm wood-lot products and are setting up a series of pasture and forest management experiments and demonstrations.

A noteworthy step in farm-forestry is embodied in recommendations made by the Station for increasing the contribution of the AAA to farm-forestry. These recommendations provide that fenced and ungrazed woodlands be recognized as part of the soil-conserving areas of farms and include a set of practices and rates of payment desirable for the region. If these recommendations, which have been received favorably by the AAA in Washington, were put into effect they would result in the contribution of \$1,250,000 to farm-forestry in Minnesota alone.

2. Pasturing Farm Woodlands Uneconomical

For a long time we have talked about the evils of the dual use of land for forestry and grazing, but we have had no concrete, dollars-and-cents evidence to back up our assertions. Now, however, our studies at La Crosse have provided such evidence. They show that the managed wood lots in that locality yield an annual return of about \$4 per acre and that the best open pastures yield about the same amount. When grazing and forestry are combined on the same area, however, yields are much less, the total annual return for a typical woodland pasture being only \$1 per acre.

3. Future Direction of Our Studies

The past year's work signals the close of the preliminary phase of the farm woodland project--the general survey of the situation and the formulation of general plans for the different conditions studied. Now we are ready to begin detailed work on specific problems of more than local application such as timber utilization, marketing of forest products, and costs and returns from the practice of forestry by small owners. In carrying forward these phases of our work it will be the aim of the Station to integrate its work closely with that of state and federal action agencies dealing with the farm woodland problem. The Station has already made significant progress toward such cooperation.

REFORESTATION

Forest planting constitutes one of the largest forest activities in the Lake States. Plans called for stepping up the planting area from 76,000 acres in 1937 and 80,000 acres in 1938, to an annual total of 100,000 acres. This huge reforestation program calls for: (1) the collection, extraction, storage, pretreatment, and testing of some 3,000 to 5,000 pounds of seed of known origin annually; (2) the yearly nursery production of some 75 to 100 million hardy, well-developed plants; and (3) their planting in the field. Insufficient knowledge at any stage of this process from the collection of seed to the production of mature plantations, the final objective of reforestation effort, may result in serious losses or complete failure.

FOREST TREE SEED STUDIES

The seed characteristics of the common conifers used in the region have now been fairly well worked out and have been embodied in present nursery practice. However, some of the empirical practices now used should be replaced by those with a more scientific basis, and furthermore, the use of a large number of new species for game food and erosion plantings provides a host of new problems with which present practice cannot cope. Some of the highlights in our recent findings regarding seed are:

1. Extraction

It has been established that the best method for extracting white pine seed is to dry the cones for 8 to 12 hours at a temperature of 40° F. and a relative humidity of not more than 40 percent. For jack pine, 6 hours of drying at 170° F. and 30 percent relative humidity is best. These kiln schedules, which were worked out by the Forest Products Laboratory in cooperation with the Station, have now been adopted by the Forest Service in this region.

2. Seed Storage

It has been further well established that white pine seed can be kept for five years without loss of viability when the seed has been dried in air at 25 percent relative humidity and stored in sealed containers at 30° F. Stored without such precautions, the viability drops to 15 and even 1 percent. Similarly, red pine seed stored in the same manner showed no loss of viability after four years. In the case of jack pine, seed from cones that had hung on the trees for as long as three and four years showed practically no loss of viability, and even seed from cones five to fifteen years old and older showed only a 25 percent decrease in germination as compared with the younger cones.

3. Pretreatment

Pretreatment of seed to increase both the rate and total amount of germination has also been worked out for various coniferous and deciduous species. White pine seed shows the best germination if stratified for 30 days at 50° F., and tamarack seed germination is greatly improved when stratified for 30 days at 41° F.

4. Seed Testing Service

To provide clinical material for its seed studies the Station carries on a seed testing service. To date about 2,770 samples involving 130 different species have been tested for federal, state, and private nurserymen in Region 9 and the prairie-plains region.

5. Preparation of Seed Manual Well Advanced

The information gained from the many seed samples tested in this laboratory, in addition to that contained in the voluminous literature, has been brought together and is now being appraised thoroughly for use in a seed manual. This handbook includes about 635 species--all American trees as well as some exotics, and a great many shrubs of native and foreign origin that have proved useful in connection with erosion control and wildlife planting programs. In addition to the work done by the Station, much information has been supplied by many of the forest experiment stations and regional offices, as well as by foresters and others in private work.

6. Future of Seed Studies

Some phases of present seed studies have gone far beyond the needs of the region and, in fact, assume national significance. They have provided the basis for the establishment of a seed testing laboratory for the entire Forest Service, the need for which is generally recognized. Should such a laboratory materialize, whether at the Lake States Forest Experiment Station or elsewhere, a firm foundation for it has already been laid. The future, therefore, of the seed studies at the Station depends on the fate of such a central seed laboratory. If plans for such a laboratory be abandoned, many of our seed studies should be curtailed and our work confined to only a few immediate problems of the region.

PRODUCTION OF NURSERY STOCK

Of the three phases of reforestation research--seed, nursery, and planting--the production of nursery stock has been most neglected. Not that there has been any lack of studies and experiments in nurseries, but for the most part they were neither scientifically designed nor fundamental in character. Only within the last two years, at least at our Station, has a serious attack upon nursery problems been initiated, but already it has yielded some gratifying results. This work has been made possible only through the financial cooperation of the Regional Forester.

Some of the many failures in past planting can be traced definitely to poor nursery stock.

1. Nutrient Balance in Nursery Key to Healthy Planting Stock

Fertilizer tests at the Hayward Nursery, the soil of which is naturally low in mineral nutrients, showed strikingly that seedlings in plots not treated with phosphorus literally starve and are unable to withstand the first winter satisfactorily. Plots untreated with phosphorus were found to have a stand per square foot of only 30 to 50 percent of that in treated plots. Size, color, and vigor of seedlings were in proportion to the treatment.

Some preliminary pot tests also indicated that phosphorus increases root development and drought hardiness whereas much readily available nitrogen decreases drought resistance.

If seedlings under nursery conditions show such heavy losses due to poor nutrient balance, it seems reasonable to suppose that under more rigorous field conditions where low soil moisture and competition make growth and survival even more difficult, such losses would be accentuated manyfold.

The whole field of nutrition of conifers, including the role of many elements other than phosphorus, such as nitrogen, potash, calcium, magnesium, manganese, iron, and sulphur, will warrant continued study.

To date the important finding in regard to proper fertility practice in forest nurseries of Region 9 is that such practices must be varied to meet the needs of the individual nurseries, based on field tests and to some extent on soil analyses.

On the basis of present experiments, lack of available phosphorus and organic matter is the outstanding cause of poor development of nursery stock. Available nitrogen is also deficient in most of the nurseries.

It appears that one of the uniformly good treatments in all nurseries in which experiments have been conducted consists of 14 to 20 tons of peat (dry-weight basis) applied per acre, supplemented with 300 to 400 pounds of ammonium sulphate, 600 pounds superphosphate, and 160 pounds potash. The above treatment gave results equal to a nearly similar amount of compost even where two successive crops had been taken from the soil.

2. Density of Sowing Determines Quality of Planting Stock

Density-of-sowing studies, which are already yielding practical results, indicate that the best seedling stock for field planting is produced at somewhat low densities, not over 40 to 60 per square foot of seedbed. The recommended density depends on fertility level, whether the stock is to be used for field planting or transplanting, and whether it is to be transplanted for one or two years. For instance, where red and white pine and white spruce are to be grown to 2-2 stock, seedbed densities as high as 70 or 80 per square foot probably can be used safely, but where the pines are to be grown for only one year in the transplant beds, seedbed densities must be lower and the stock culled more heavily.

3. Watering an Important Factor in Producing Hardy Stock

Considerable progress has been made in developing proper watering methods. Indications are that underwatering of jack pine may be just as harmful as overwatering. Tests conducted at Hayward and Hugo Sauer Nurseries in 1937 and 1938 showed that 2-0 jack pine

stock was weakened if the soil moisture content remained near or below the wilting coefficient for a period of several days. Overwatering, on the other hand, resulted in topheavy 2-0 jack pine stock at Chittenden Nursery-- an undesirable characteristic in nursery stock.

As an aid to nurserymen in determining available moisture content of soil and thus to regulate their watering practice, 30 moisture meters based on the tensiometer principle were constructed and distributed to 15 different nurseries. The meters were calibrated for each location in each nursery and a scale attached showing total moisture percent. The wilting coefficient was indicated on each scale, so the available moisture content could be computed rapidly in the field.

4. Cold Storage of Stock Promises to Spread Planting Load

The question of cold storage looms large in the present planting program because a considerable investment has been made at a number of nurseries for mechanical refrigeration plants. These have proved of benefit in distributing work load in the nurseries and in field planting, through providing a place where stock intended for field planting can be stored safely without great danger of loss from drying, mold, and heating. It was also thought that such storage plants would be of value in extending the planting season.

To answer part of the problem of storage, the Station, at the suggestion of the Regional Office, started an experiment in the spring of 1938 in which both survival and growth of stored stock were studied. Storage periods of 0, 1, 2, 3, 4, and 5 weeks at 50° F. showed a drop in field survival from 99 percent for unstored stock to 81 percent for stock stored five weeks. Stock stored four weeks did not appear to be harmed much, since it gave 93 percent survival. Present indications are that temperatures of 38° to 40° F. will be better for storage of conifer stock than 50° F.

5. Field Planting Must Tell the Story

During the past two years over 2,000 nursery plots have been established to test various phases of nursery practice. The stock raised in these plots has been, or will be, field planted, and the final appraisal of each treatment rests upon these field tests. For the next year or two at least, work will be confined largely to observing the behavior of the planted stock. New nursery studies will be made only after present studies have been evaluated by these field tests.

FOREST PLANTING

The results of forest planting experiments are watched most closely by the national-forest administration, and as soon as they can be reduced to a practical and workable basis they are adopted as standard practice.

1. Discoveries of Yesterday--Practice of Today

The value of research is attested by the extent to which its findings are put into practice.

Formerly the national forests used seedling stock almost exclusively in their planting operations. Today they use transplants to a large degree, especially in difficult situations.

Formerly the national forests used red pine alone for planting on the poorer sand plains and only too frequently with poor success. Since 1934 they have been using jack pine in such situations with considerable success.

Formerly the slit method was used almost exclusively in planting operations on the national forests. Today they use the wedge or center-hole method for planting larger stock to overcome the detrimental effects of slit planting.

Formerly most underplanting was done without any subsequent release work. Today practice involves weeding and release.

Formerly practically all seedlings produced in the nursery were planted regardless of size or development. Today from 10 to 50 percent of the seedlings are discarded at the nursery because they do not meet grading standards developed cooperatively by the Station and the Region.

Prior to 1937 the average survival on national-forest plantations seldom exceeded 50 percent and in 1936 was only 37 percent. For the last two years, survival is about 75 percent. Even allowing for more favorable moisture conditions, this goes to show what cooperation between administration and research can do in improving forest planting.

2. Control of Sand "Blows" by Tree Planting

A distressing feature of the landscape in northwestern Lower Michigan is the ubiquitous sand "blow" ranging from a few square feet to hundreds of acres in size. These sand "blows" are not the moving dunes of the Lake Michigan shore, but lie inland and are the result of destructive agricultural practices. One such sand "blow," covering some 600 acres, is on the Manistee National Forest. Unless controlled, it will encroach further and further on productive land. It appeared evident from experiments that such "blows" can be reclaimed directly to forest by covering them with brush and then planting trees.

3. Success of Plantation Depends on Early Root Development

Roots of planted conifers, it was found, grow chiefly downward during their first year in the field and chiefly laterally, as much as 3 or 4 feet in radius, during the second year. If this apparently natural root development is not hampered either by poor planting, poor stock, or severe weather conditions, two favorable years following planting may insure successful establishment.

The method of planting must permit the natural habit of root development peculiar to each species. Jack pine, which is primarily a shallow-rooted species, survived much better when planted in a shallow wedge hole than when planted in a deeper wedge hole or in slits. Evidently planting methods which provide the most natural root placement can pay dividends in terms of survival.

4. Transplants Not Only Survive Better But Also Grow Faster

That transplant pines survive better than seedlings because they are better able to withstand drought, heat, smothering, and competition has been proved by previous experiments. Last summer's measurements, five years after planting, have shown that transplants not only survive better but they also grow faster. Such extra growth during early years is of prime importance in preventing smothering by leaf litter and overtopping by low vegetation.

5. Reforestation of Northern Hardwoods Promising

Experiments in planting of hardwoods have been almost neglected in the past. There is a definite place for such planting on the national forests but on a more limited scale than that involving conifers.

That planting of northern hardwoods in the northern Lake States can be fairly successful has been demonstrated on the Nicolet National Forest. With some hardwood species such as red oak and, to a less extent, yellow birch, even direct seeding proved successful.

6. Heavy Equipment Practical for Reforestation of Brushy Lands

The use of heavy equipment such as the Olympic plow and the Athens plow in combination with powerful tractors, on the Chippewa Forest, has opened up an avenue which promises to make the application of intensive forest planting practice fairly inexpensive and simple and, therefore, workable. The obstacle to the successful planting of brushy lands, or conversion of aspen to conifers, was the cost and time involved in removing competition from overstory and undergrowth. The use of heavy equipment makes the application of this practice feasible on a large scale.

How important for the success of planting the removal of competing vegetation is, is shown by the fact that on the Superior Forest even a single weeding made during the first growing season may be sufficient to bring through jack pine planted on brushy sites; plantations not given such treatment failed. Any reduction in the amount of cultural work naturally increases the economic feasibility of planting.

7. Next Step in Planting Research

Past results of planting studies have solved, in the rough, many of the problems concerning size of stock, methods of planting, selection of species, seed source, direct seeding, and planting under aspen or brush. Studies in all these fields to improve general practices further to fit

specific conditions must and will, of course, go on as long as forest planting constitutes an important forest activity in the region. However, there has now been accumulated sufficient reliable information as to planting practices to assure fair success under normal conditions. From now on we should aim, without abandoning the refinement of the general methods already developed, to shift the emphasis of our work toward developing methods of aftercare necessary to bring plantations through to maturity. With the large acreage of national-forest plantations now established, the problems of weeding, release cutting, thinning, pruning, and building up understocked plantations, are going to become increasingly more pressing. We should be prepared to offer guidance for such work when it is first needed and not have to jump in to develop such information after the shoe begins to pinch.

FOREST MANAGEMENT

MORE LIGHT ON REPRODUCING JACK PINE

Previous experiments have demonstrated clearly that scarification of the ground and the spreading of cone-bearing jack pine branches over it are the essential factors in securing natural reproduction of jack pine. This practice has now been tested out on a fairly large scale on the national forests of the region. On the basis of last year's experience it is possible now to determine more precisely the conditions essential for satisfactory reproduction of jack pine.

1. Soil Scarification Must Be Thorough

On the Chippewa Forest, preliminary attempts at scarification with a Killifer planting plow indicate that too small a proportion of the soil surface was exposed to bring about satisfactory reproduction. Yet even with this inadequate preparation, where only 10 or 15 percent of the mineral soil was turned up, 1,750 seedlings per acre were present one year after cutting, practically all on disturbed ground. The more complete scarification that has been achieved with the Athens disk has increased the percentage of exposed mineral soil to 40 or 50 percent of the ground surface. It is anticipated that this treatment will result in better stands of reproduction.

2. Proper Slash Disposal Essential

A primary consideration is that the cones in the slash must be well scattered over the exposed mineral soil or else the seeds will not be adequately distributed. Prompt opening of the cones can be assured only if they are placed close to the ground. Cones lying on the ground fully exposed to the sun will open in about one week of hot weather. When suspended 6 inches above the ground, one to two months of exposure are required. Opening becomes progressively slower as the distance above the ground is increased, so that at a height of 4 to 5 feet cones may open only after two or three years or they may caseharden and stay closed

indefinitely. Furthermore, if the slash is too thick the seedlings will have difficulty in getting through and their growth will be retarded. This is especially true on cool sites where slash was found to retard seedling growth from 50 to 80 percent.

On the other hand, on southerly exposures or dry sites, survival will be better under a light shade of slash. The beneficial effect of the slash is primarily due to the reduction in surface temperatures. Temperatures above 120° F. cause the death of young seedlings. Even at the northern latitude of the Superior Branch, temperatures greater than this and up to 158° F. occurred commonly on the bare, unshaded forest floor, whereas a thin layer of slash prevented temperatures from rising much above 100° F. Obviously, the retention of slash and a lighter degree of cutting are called for on hot, south exposures.

3. Timing Seed Dispersal

In the tests so far undertaken, most of the seed has been released during the middle of the summer. Seeds scattered at this time are apt to germinate during the autumn and the seedlings may be too weak to survive the winter. Under Superior Forest conditions, seedlings germinating in the spring have three times as good a chance of surviving as those germinating in the fall. Thus, it would be a decided improvement in the method if a way could be found to bring about dissemination of seed late in the fall, winter, or in the very early spring so as to have it on the ground ready to germinate with the first warm weather. Moreover, unless the seedlings have an early start they will suffer from competition with the vegetation that quickly invades cut-over areas. Seedlings growing in natural competition with herbaceous growth were only one-sixth as large as those that had been weeded and had developed freely. The failure of seed dispersal to coincide with the time when the opportunity is best for establishment of seedlings is a problem requiring further investigation.

4. Plans for the Future

Since the principles of how to obtain jack pine reproduction seem to be pretty well worked out, intensive studies will be somewhat curtailed and efforts during the coming year will be devoted largely to extending still further the application of the findings to large-scale woods operations; also to preparing the results of the study for formal publication.

HANDLING NORTHERN HARDWOODS

1. Light Cuttings in Hardwoods Show High Quality Increment

The advantages of light cuttings in increasing quality growth of the residual stand were brought out by the analysis of three of the experimental cuttings (light, moderate, and heavy) that have been in effect for ten years. In the heavy cutting the growth was mostly on

small saplings, in the moderate cutting it was distributed over quite a range of diameters, and in the light cutting growth was confined to the large trees.

The extensive mill-scale studies carried on a number of years ago in connection with selective logging established a definite relationship between diameters of trees and value of the lumber per M feet cut from them. By applying these values to the increment obtained in the three types of cutting, the growth per acre per year was computed to be worth \$4.25 for the light cutting, \$2.67 for the moderate cutting, and \$0.68 for the heavy cutting. These differences are further accentuated by the fact that the value given for the light cutting could be realized immediately if it were necessary to cut it, whereas that from the heavy cutting is scarcely realizable at all since the stand is too light to warrant returning for a second cut within a reasonable period. Admitting that the mill-scale values may be somewhat changed today, the relationships remain the same, and it is perfectly clear that the light cutting has given much the best results in quality growth.

2. Full Development of Dukes Forest Awaits Revival of Lumbering

Further progress in the study of northern hardwoods will depend on the rapidity with which the working plan for the Upper Peninsula Experimental Forest is put fully into effect. During the past year, because of the general economic recession the demand for logs and lumber was limited, and instead of cutting 500 M feet as the annual cutting budget calls for, the Station succeeded, in spite of strenuous efforts, in disposing of only about 200 M feet. Most of the efforts of the last year went into the organization of the Forest and it is felt that the ground for further progress has been laid. From now on there should be continuous dividends paid not only on the financial investment in the property but also in the better knowledge of how best to handle northern hardwoods.

BLACK SPRUCE ASSUMES GREATER IMPORTANCE

Black spruce, because it covers more extensive areas of virgin forest than any other conifer in the Lake States and commands the highest stumpage price for pulpwood in the region, has recently assumed greater economic importance.

Past studies dealt with the effect of drainage upon the growth of black spruce in deep peat swamps. In recent years, more attention has been given to productive swamp forests and mostly from the standpoint of natural reproduction and methods of cutting. The observations made thus far point to a rather surprising conclusion.

1. Black Spruce a Fire Species

Black spruce, which was always supposed to have its feet in wet ground and usually forms all-aged forests, has been found, like jack pine

and lodgepole pine, also to be a follower of fires. Practically all of these swamp forests have remnants of charcoal in their peat profiles, which would indicate that they have been burned over in the past. The all-aged appearance is due to subsequent natural reproduction, but the main stand or overstory is largely all of the same age. What, then, makes black spruce a species capable of reproducing itself after fire?

2. Black Spruce Has Peculiar Seeding Characteristics

In jack pine and lodgepole pine there is a reserve supply of seed in the unopened cones which is released after fires. In the case of black spruce, although its cones open the same year they ripen, all of the seed is not released at once. In a study designed to determine how long the seeds remained in the cones, newly ripened cones yielded seeds at the rate of 416,000 per acre, one-year-old cones 321,000, and older cones 429,000. In addition to conserving its seeds by means of persistent cones that open very slowly, black spruce cones are borne in a dense cluster at the top of the crown where they are most apt to escape injury by fire.

Earlier observers concluded that black spruce, where it had followed fire, originated from seed blown in from wet swamps that had not burned. Although black spruce seed in a high wind may travel long distances, the relative amount dispersed at distances of more than a few hundred feet is not large. Seed-trap records at the Superior Branch indicate an annual seedfall of about 300,000 seed per acre in uncut stands, about 18,000 at 100 feet distant from uncut timber, but only 6,000 per acre at a distance of 200 feet. Obviously, at distances exceeding this the amount of seed would be too small to explain the excellent even-aged reproduction of black spruce frequently found on extensive burns.

The burning of the ground surface, which prepares a good seedbed, is undoubtedly an important factor in facilitating reproduction. However, it is not as vital to reproduction as in the case of jack pine because natural reproduction of black spruce takes place in the swamps all the time, though slowly on undisturbed ground.

The characteristics that enable black spruce to reproduce naturally after fire should have a bearing on the best method of cutting and reproducing it.

3. Clear-Cutting vs. Partial Cutting

Clear-cutting and selection cutting give about equal promise as far as natural reproduction is concerned. No matter how or at what time the cutting is done there is always a certain amount of freshly fallen seed upon the ground and more is distributed from the seed stored in the cones as logging takes place. In the case of clear-cutting, practically all of the advance growth is lost, but by the use of a selection system there is a possibility of saving this timber, thereby shortening the intervals between cutting.

The chief obstacle in case of partial cutting is the susceptibility of residual trees to mortality from wind and exposure. The advantages and disadvantages of both systems of harvesting, especially with respect to mortality of residual trees, will be the principal phases investigated during 1939. Cuttings will be studied in cooperation with state and federal forest services.

FOREST MENSURATION

1. Region's Need for Independent Mensuration Projects Declining

The phase of forest mensuration that deals with the preparation of general utility volume and yield tables is gradually coming to an end. But forest mensuration as a service in the solution of many specific problems in connection with all the other work of the Station is assuming an increasingly important function.

At the time the Station was established, the region was lacking in the most elementary information regarding the volume of trees and the growth of stands. Before the Station could undertake studies of forest management, it had to develop yardsticks by which to measure the stock. The first efforts, therefore, were directed toward preparation of yield tables, studies of stand composition, and experiments in volume-table technique.

2. Growing Need for Statistical Help in Other Projects

With addition of new projects, particularly the Forest Survey and farm wood-lot study, and with development of new techniques applicable to reforestation and silviculture, new responsibilities have devolved upon the forest mensuration specialists.

In connection with the Forest Survey, it was necessary to assist in the preparation of a new set of volume tables to standard specifications. A simple yet reliable method was devised whereby 150 tables covering 32 species were prepared. A large amount of work was done in analyzing the reliability of extensive line-plot surveys. Assistance was given in devising a suitable method of measuring current growth and allowable cut. Fifteen empirical yield tables were worked up and a method described for their application to understocked stands.

The farm wood-lot study of 1938 called for the development of a quick, inexpensive, but fairly accurate method of cruising small tracts. Such a method has now been developed.

Assistance was given in designing experimental technique for studies of drought resistance, the influence of shelterbelts on crop yields, production of nursery stock, cold storage of nursery stock, and in field planting.

The work in connection with the Forest Survey has resulted in the preparation during the past year, in manuscript form, by a Station member and a member of the Washington Office staff, of a comprehensive cruiser's handbook embodying suggestions on survey methods, preparation of volume tables, rules of thumb for estimating timber, and shortcuts of all kinds.

In the interests of efficiency, a computing unit was set up at the Station, where preliminary compilations from all divisions are handled and final reports are checked.

3. Future Needs

Forest mensuration as a service in the solution of problems in all divisions of the Station is becoming increasingly important. From now on the work in mensuration must be directed more and more toward: (1) the solution of detailed, specific problems in connection with other studies, and (2) the application of statistical techniques to the design of experiments and analysis of the results.

FOREST FIRE RESEARCH

1. Fire Protection in Lake States over 90 Percent State Problem

At the time the Station was established, there were only three small, relatively unimportant national forests in the Lake States, and the demand upon the Station for accurate data upon which to build improved protection practices was comparatively small. Still, fire research has been an important activity at the Station since its inception in 1923. In the past, most of the work was devoted to state problems, to compilation and analysis of fire and climatic data, and to general appraisal of the fire problem. However, with the establishment of Region 9 and the rapid expansion of federal holdings, the attack on the fire problem had to be reoriented radically. Still, fire protection in this region is 90 percent a state problem, and the complete absorption of our fire protection efforts by national-forest demands would be rather unfortunate. For this reason an effort was made last year to reestablish intimate contact with state protection officials and to concentrate on a few fire problems common to the three States.

2. Standard Damage-Appraisal Methods Adopted in Lake States

One result of the contact with state men was the calling of a tri-state conference on damage appraisal at which a common policy was agreed upon and standard appraisal methods and base values adopted. At the request of this conference the Station prepared damage tables for national-forest and state use throughout the region, something which did not exist before.

3. More Adequate Support Needed

Despite the great need of the states for information on fire protection, the demands upon the part of national-forest administration are

increasing in insistency, urgency, and volume. The Station now serves not only the northern part of Region 9 but also the southern part which is within the territory of the Central States Forest Experiment Station.

Aside from carrying on several projects of fundamental character, such as effect of forest cover on fire danger, development of fire danger meters, and behavior of forest fires, the Station is aiding in the inspection and establishment of fire danger stations on the national and state forests, analyzing local fire and weather data, and preparing instructions. During the past year, for instance, some 50-odd state and federal stations were inspected and the local reliability of the danger meters checked.

All this is increasing the strain on our resources, already inadequate. At present the entire personnel in fire research consists practically of one man. Either fire research should be provided for at the Central States Station, or the work in that region should be recognized as our responsibility and adequate provisions made for it. One possible solution of the difficulty would be to place in the Regional Office one man to handle fire research for both Stations and to provide permanent junior assistants at each Station to handle work locally under his direction.

Prior to last July 1, CCC research funds were available. Now these funds are gone, and the Region also, through curtailment of funds and other economies, is no longer able to make financial contributions to the Station for this purpose. As a result the Station now finds itself with a heavy responsibility but with diminished funds to carry on.

FOREST INFLUENCES

Studies of the influence of the forest have been carried on at two widely separated points, the prairie-plains states and Wisconsin. In the prairie-plains states the study was confined to the effects of shelterbelts on wind movement, evaporation, and yields of crops. In Wisconsin the effect of vegetative cover upon streamflow and erosion was studied.

1. Multiple Barriers Increase Effectiveness

The most important progress not previously reported was made on the study of multiple barriers; that is, a series of artificial barriers comparable to several tree shelterbelts spaced at distances from 20 to 30 shelterbelt-heights apart. Indications are that with winds at right angles to them, a series of four barriers has an effectiveness approximately five times that of a single barrier comparable in size and structure.

2. Crop Yields Invariably Increased by Shelterbelt Protection

Out of some 50 cornfields measured in Kansas, Nebraska, and South Dakota during 1938, a year of fairly favorable moisture conditions, practically all showed significant benefits within a zone of 10-12 heights behind the shelterbelts. These results, however, cannot be considered conclusive, since observations must be continued over a period of several years.

3. What Is Needed

To build up a solid body of facts on the influence of shelterbelts on crops, it would be most desirable to put a considerable number of the newly established Forest Service belts under "permanent and progressive" observation. The greatest value of such observation would be in obtaining the history of the adjacent fields under increasing protection from the growing shelterbelts.

4. Vegetation in Lake States Region Can Control Runoff and Erosion Completely

After $4\frac{1}{2}$ years of observation at our La Crosse Station on the behavior of forested and ungrazed, forested and grazed, and cleared pasture land, the ungrazed-forested watershed showed a capacity for absorbing completely all summer rainfall and essentially all of the melting snow in the spring. After $4\frac{1}{2}$ years of complete protection of the forested watershed from grazing, any scars the area had received under ordinary farm use (some grazing, a very small marginal area cultivated, and a large gully therefrom) have healed entirely. Even the waterways are now accumulating leaves and do not expose the bare rocks, which for the first two or three years made measurable surface runoff possible. On the whole this is a remarkable demonstration of the ability of forest vegetation in the region of steep slopes and heavy soils to control completely the runoff situation.

FLOOD CONTROL SURVEYS

1. Runoff and Erosion Studies Guide Flood Control Surveys

Flood control surveys, without the basic knowledge of the effect of vegetation, may often lead to erroneous conclusions. Our flood control surveys as a research activity, if they are to point out realistic ways of improving conditions, must depend on such studies as those conducted at the La Crosse Station. The connection between these studies and the Kickapoo Flood Control Survey illustrates this strikingly.

2. Elimination of Grazing Most Promising Flood Control Measure

The detailed Kickapoo Flood Control Survey (as well as other preliminary surveys) has emphasized the fact that the greatest contribution that can be made by agriculture to flood control is through the elimination of grazed woods or wooded pastures. The technicians on this survey are in

almost complete and perfect agreement that the elimination of grazing on wooded areas can reduce the runoff from whatever it may now be to practically nothing, even for the most intense flood-producing rains. Yet we must base such important calculations as this upon the experimental results from one wooded pasture of scarcely more than two acres. Actually, we do not know for many of the grazed woods being examined whether present runoff is 5, 10, or 20 percent in intense rains. Our present judgment as to the relative condition of the different wooded watersheds is based on the too small acreage under controlled experiments.

3. Extension of Forest-Pasture Runoff Studies Essential to Flood Control Program in the Lake States

While we are not inclined to overemphasize the need for close experimental work as contrasted with sound observation and analysis, there is a decided need for extending our forest-pasture-runoff studies. One can readily imagine the reaction of the Wisconsin Agricultural Experiment Station if the Kickapoo report comes out with the recommendation that 90 percent of all grazing in the woods be eliminated. For years they have "hounded" us to obtain more complete data on both the hydrological and economic value of these areas, which they feel to be essential to the dairy industry. For the last five years we have insisted on the need for extending these studies to other typical watersheds in the region so as to have a broad basis upon which to make definite recommendations.

The moral is that it is unwise to put most of the "influences funds" in one or two nests and expect to develop concrete flood control measures elsewhere on a shoestring.

WILDLIFE RESEARCH

To furnish the necessary knowledge basic to forest wildlife management and to determine how such practices should be integrated with forest management activities in the region, experiments have been conducted by the Biological Survey in cooperation with the Station since 1930. Past studies have dealt largely with forest birds, the snowshoe hare, and migratory waterfowl. The more significant results of 1938 have to do with food habits of deer and beaver.

1. Food Habits of Minnesota Deer

To learn why deer in the north woods are fat and in good condition during the fall hunting season and thin and weak in the late winter, the stomachs of 22 deer killed in the fall and 52 killed in late winter were collected and the contents analyzed. These examinations revealed that 45 plant species were eaten during the fall and only 25 in the winter. Although evergreens, including balsam fir, pine, white cedar, and spruce, formed only a little over one-fourth of the fall diet, they composed almost three-fourths of late winter feed. White cedar, the most valuable of the deer browse species, increased only 3 percent in the

winter diet, the greatest bulk being derived from balsam and pine. Willows and poplars formed 29 percent of the fall diet but decreased to less than 4 percent of the late winter diet. Species of the heath, honeysuckle, and birch families were minor items of diet during both periods.

The conclusions drawn from this study, in conjunction with available browse surveys, were: (1) that the winter carrying-capacity for deer in northeastern Minnesota is on the decline; (2) the browse species that form the greater part of the winter food are not of the greatest nutritional value; (3) many of the choice browse species are either characteristically rare or are becoming unattainable due to heavy browsing in previous years; (4) balsam fir, which may be good deer browse when eaten in moderate amounts in combination with nutritious foods, is not capable of maintaining good health when eaten alone or in too great a proportion to other foods; (5) maple brush is the most generally available of the choice browse species in this area; other desirable species may be abundant locally but are more spotty in their distribution; (6) jack pine is browsed more severely than red or white pine, and in some areas jack pine reproduction is being damaged severely and tree growth retarded by heavy deer browsing; (7) the variation in the availability of certain browse species in different concentration areas indicates that management practices will have to be developed for and applied to rather limited areas.

2. Beaver Not Model Conservationists

Contrary to public opinion, the beaver is not a good conservationist as far as utilizing his food supply is concerned. According to detailed studies made at five occupied dams in northern Minnesota, the beaver wasted 64 percent of the food potentially available from 456 felled aspen because of lodging of the trees, obstructions in the landscape, or discrimination for the tender tops of the larger trees with the resulting waste of the trunks and larger branches. These studies further showed that aspen is the beaver's choice food, with white birch, alder, and willow next in importance.

3. Further Studies Contemplated

Studies now under way or contemplated include determination of (1) the advisability and practicability of environmental manipulation in deer management, (2) the effects of deer and rabbits on forest composition, (3) the quantity of beaver food to be expected from aspen stands of known composition and volume, (4) the responsibility of animals for failure of coniferous reproduction following logging and fires, (5) the life histories of sharp-tailed and pinnated grouse, (6) life history of the snowshoe hare in greater detail.

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136. How to Obtain Effective Dispersal of Jack Pine Seed. February
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137. Peat or Sand for Covering on Spruce Seedbeds? February 1938.
138. Earlier Returns from Thinned Red Pine. February 1938.
139. Water Tables and Survival. February 1938.
140. Deep Rooting and Plantation Survival. February 1938.
141. When to Cut Jack Pine. February 1938.

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Can the Wisconsin Paper Industry Answer the Challenge from the South?
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The Release of Seeds from Jack Pine Cones. By R. K. LeBarron and
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Practical Cutting Methods for Northern Hardwoods. By F. H. Eyre.
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Stoeckeler and C. G. Bates. (For Journal of Forestry)

Why Forest Plantations Fail. By Paul O. Rudolf. (For Journal of Forestry)

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January 1939

HARVEST CUTTINGS (NORTHERN HARDWOODS)

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Silviculture.
3. LINE PROJECT: Harvest Cuttings (Northern Hardwoods)
4. PURPOSE OF WORK: To determine the silvicultural soundness and economic feasibility of selective cutting in mature northern hardwoods.
5. REVIEW OF PAST WORK: Based on mill-scale studies in cooperation with the Forest Products Laboratory, the cost of logging small and large-sized timber was worked out. Pending results of actual cutting experiments, the growth of residual stands was determined by a survey of areas "accidentally" cut to varying degrees. The silvicultural practicability of selective cutting in northern hardwoods as compared with heavy diameter-limit cutting and clear-cutting has been studied in a series of cutting experiments. All phases of the project now integrated in the management of the Upper Peninsula Experimental Forest, a 5,000-acre tract supporting a stand of mature hardwoods. On this area demonstration cuttings on a commercial scale have been started in accordance with a definite plan of sustained-yield management.
6. ACCOMPLISHMENTS DURING PAST YEAR: Although market conditions during past year did not permit putting management plan fully into effect, over 200 M feet were cut from an area of some 75 acres under a light selection method. The advantages of a light type of cutting in quality growth of the residual stand were brought out by the analysis of three of the experimental cuttings made ten years ago.
7. PLANS FOR NEXT YEAR: If the market improves, the management plan for the Upper Peninsula Experimental Forest will be put fully into effect by the end of the year. Since the manufacturers pay a premium price for maple logs containing a high percentage of "white wood," a study is needed to determine if the growth of "white wood" can be increased by silvicultural practices. This study to be made as soon as the Experimental Forest is on a "going" basis.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: F. H. Eyre and J. R. Neetzel.

January 1939

HARVEST CUTTINGS (SWAMP FORESTS)

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Silviculture.
3. LINE PROJECT: Harvest Cuttings (Swamp Forests).
4. PURPOSE OF WORK: To determine best cutting and reproduction methods in swamp and swamp border types (chiefly black spruce), and relation of growth of swamp forests to water levels and removal of excess water.
5. REVIEW OF PAST WORK: Survey of growth as affected by drainage for agriculture (but never so utilized) undertaken 1925 indicated increased growth along drainage ditches. Experiments in control of water in peat swamps started in 1927 at Chippewa and Upper Peninsula Branches. Chippewa plots show accelerated growth. Survey of nine cutover swamps in Superior Forest made in 1931 showed fairly good reproduction in all cases. Experimental cuttings in black spruce established Superior Branch 1934 and 1935. Hundred-foot strip cutting not entirely satisfactory. Light selection appears to be most promising. Conservative logging methods therefore give promise of increasing yield and reducing cutting cycle. The more productive swamp border stands present difficult problems of regeneration because of competition from other species.
6. ACCOMPLISHMENTS DURING PAST YEAR: Black spruce found to conserve its seed and disseminate it over period of two or more years after ripening, and at any given time large supply of seed is present in its persistent cones. Since this seed may be released after fire, this explains how large burned areas have so successfully reproduced to black spruce. Slash resulting from heavy cutting found to be so dense as to cover 50 percent of ground surface, thus reducing opportunities for reproduction. Swamps characterized by cover of Labrador tea sufficiently productive to warrant management, but those characterized by leatherleaf are too slow-growing for production of commercial timber. Moreover, Labrador tea sites are relatively easy to reproduce to spruce when compared with drier situations.
7. PLANS FOR NEXT YEAR: Studies of natural regeneration and methods of cutting in black spruce swamps to be continued, with special emphasis on mortality following selection cutting. Christmas tree production will be given some consideration.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: F. H. Eyre, R. K. LeBarron, H. L. Shirley, and J. R. Neetzel.

HARVEST CUTTINGS (PINE TYPES)

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Silviculture.
3. LINE PROJECT: Harvest Cuttings (Pine Types).
4. PURPOSE OF WORK: To determine methods of cutting, slash disposal, and soil disturbance which will result in satisfactory regeneration and growth of the pine types (jack pine, red pine, white pine). The greatest emphasis is placed on jack pine because of its large relative importance compared with the other Lake States pines.
5. REVIEW OF PAST WORK: Cutting experiments and observations on reproduction started in jack pine in 1926 on Chippewa and Superior National Forests, extended to Huron Forest 1935. Red pine cuttings begun 1926, Chippewa Forest only. Studies of white pine entirely incidental. Major results: Jack pine unreliable as seed tree without fire, but cones in slash exposed to sun open during summer and disperse much seed. Mechanical disturbance of forest floor greatly increases pine reproduction. Rotations up to 70 or 80 years found satisfactory for jack pine. Light intermediate cuttings in pole stands of mixed jack and red pine found profitable.
6. ACCOMPLISHMENTS DURING PAST YEAR: Experimental results were given practical test on three national forests of region, with Athens disk-type plow proving to be most useful tool for mechanical scarification of forest floor. Slash found to retard early growth of seedlings but to increase survival on hot, dry situations due to reduction in surface temperatures. Cones in slash must lie within a few inches of ground to open promptly. Seedlings germinating in spring survive three times as well as those germinating in fall. Preliminary studies by Station biologist indicate rodents influence jack pine reproduction less than previously supposed.
7. PLANS FOR NEXT YEAR: Intensive studies of jack pine reproduction to be gradually curtailed and efforts to be mainly devoted to preparing results for formal publication. Annual cutting in jack pine on the Chippewa, omitted during 1938 because of poor market, to be undertaken in 1939. Cutting experiment in red pine likewise scheduled for 1938 and only partially completed for same reason, will be concluded in 1939 if markets improve. Method of obtaining jack pine reproduction already worked out will be applied to woods operations on practical scale wherever opportunity presents itself.
8. DATE OF COMPLETION: Phase of study involving intensive experiments in jack pine reproduction to be concluded in 1939. Completion of other phases indefinite.
9. ASSIGNMENT: F. H. Eyre, R. K. LeBarron, H. L. Shirley, P. O. Rudolf, and J. A. Mitchell.

January 1939

HARVEST CUTTINGS (ASPEN)

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Silviculture.
3. LINE PROJECT: Harvest Cuttings (Aspen).
4. PURPOSE OF WORK: To determine how aspen can be handled economically so as to ensure the maximum yield of high-quality products and vigorous growth of reproduction following cutting.
5. REVIEW OF PAST WORK: Cuttings established in 1925 in 38-year-old aspen have shown that by judicious partial cutting the rapid growth rate of young stands can be maintained up to 48 years of age and beyond. In stands 45 years of age, little is to be gained in volume, and much is added to logging costs by cutting to an 8-inch diameter limit instead of to a 9-inch limit. The latter is far better silviculturally and probably will result ultimately in much greater yield. Clear-cutting results in an excellent stand of thriftily growing suckers.
6. ACCOMPLISHMENTS DURING PAST YEAR: The feasibility of making partial cuttings in accessible aspen, removing as little as 2,000 board feet per acre, has been demonstrated. Trees left responded immediately by increasing leaf and crown area.
7. PLANS FOR NEXT YEAR: Further large-scale selection cuttings will be made to test the feasibility of light cuttings. The growth aspects of selection cutting will be studied as the plots available for this purpose become older. At least 15 years must elapse before satisfactory data on how to obtain maximum yield of valuable products, such as veneer logs, can be accumulated.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: H. L. Shirley.

January 1939

STAND IMPROVEMENT

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Silviculture.
3. LINE PROJECT: Stand Improvement.
4. PURPOSE OF WORK: To discover the silvicultural and economic value of thinning and release cutting in the forest types of the Lake States.
5. REVIEW OF PAST WORK: Thinning plots in red pine established on Chippewa Forest in 1927 show that increased growth rate on thinned plots has advanced date of harvest cutting by at least 10 years. Jack pine thinning plots established on Chippewa Forest in 1929 and on Superior Forest in 1934 and 1936 have resulted in accelerated growth rates. Release cuttings established in pine plantations on Higgins Lake State Forest in Michigan 1929 (in cooperation with University of Michigan), Superior Forest 1931, and Chequamegon Forest 1932. Liberation work begun in natural stands of white pine on Chippewa Forest 1932 and 1934, and in spruce on Superior Forest 1932, has caused increase in crown densities, thickening of stems, and improved rates of growth. Series of aspen thinning plots in stands of ages 2, 13, and 20 years established on Chippewa 1929 to 1936. Stand improvement of young northern hardwoods begun at Upper Peninsula Branch 1933. All experiments have served as guide to or check on CCC stand-improvement activities.
6. ACCOMPLISHMENTS DURING PAST YEAR: Five-year examination on young hardwood release and thinning suggests that cuttings heavy enough to improve rate of growth will cause undesirable branching of crop trees. Composition improvement is one of the main advantages of stand improvement in young hardwoods. Removal of aspen overtopping hardwoods may well be delayed until it becomes of merchantable size. Thinning in 30-year-old aspen was added to Chippewa series.
7. PLANS FOR NEXT YEAR: This project will be largely inactive during the coming year because little more can be learned from these studies until the trees approach size for harvesting.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: F. H. Eyre, H. L. Shirley, R. K. LeBarron, and J. R. Neetzel.

CORRELATION OF FOREST TYPES WITH SOILS AND
PLANT INDICATORS

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Silviculture.
3. LINE PROJECT: Ecology.
4. PURPOSE OF WORK: To determine, on the basis of soil classification and plant indicators, the potential cover and productive capacity of deforested land and areas occupied by inferior second growth or brush, and to prepare accurate maps of the natural forest cover for the three Lake States.
5. REVIEW OF PAST WORK: The major findings to date are as follows:
(a) The characteristic forest cover has been determined for some 150 different soil types of the U. S. Soil Survey. (b) The productivity of about 75 of these soil types has been rated in terms of various species. (c) There have been determined 14 soil groups based on the texture of the surface layer and the nature of the subsoil in conjunction with the relative depth to water table. These also show a significant relationship to forest type and to site index. (d) Characteristic under-vegetation has been worked out for six forest types and groups of types. (e) Five vegetation maps have resulted more or less directly from the project. (f) Results of the project have been made available in the form of technical notes and brief articles.
6. ACCOMPLISHMENTS DURING PAST YEAR: Except for a small amount of time spent in working out the western limits of the range of beech in Upper Michigan and Wisconsin, this project was inactive during 1938.
7. PLANS FOR NEXT YEAR: The outline for the final report will be thoroughly reviewed and revised so as to stress such phases of the project where the data is most nearly adequate. Time and funds permitting, any additional analysis required will be completed and the final report written.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: E. I. Roe.

STAND STUDIES

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Mensuration.
3. LINE PROJECT: Stand Studies.
4. PURPOSE OF WORK: To determine laws governing development, growth, and yield of forest stands.
5. REVIEW OF PAST WORK: Stand tables were prepared for fully stocked stands of aspen, white and jack pines. These tables enabled the construction of normal yield tables for any desired merchantability standard. Empirical yield tables were prepared for determining growth and yield of northern hardwoods, bottomland hardwoods, spruce, balsam fir, white pine, aspen, and jack pine types. Formulae for evaluating the approach of understocked stands to normality were worked out for the most important types in the region.
6. ACCOMPLISHMENTS DURING PAST YEAR: Special tables were developed for calculating the current growth of uneven-aged and understocked stands of aspen, jack pine, and northern hardwoods. Such tables were made available in Economic Notes No. 9. The technique of growth prediction and site determination in uneven-aged timber stands was written up in the Journal of Agricultural Research.
7. PLANS FOR NEXT YEAR: (a) Growth and yield tables will be prepared for the oak cover type on the basis of comprehensive material collected throughout the Lake States during the past few years. (b) Study will be made of growth of stands as it is affected by spacing and by cultural operations, such as the age of thinning, tree sizes removed, kind of trees removed, and severity of cutting.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: S. R. Gevorkiantz and Staff.

January 1939

TREE STUDIES

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Mensuration.
3. LINE PROJECT: Tree Studies.
4. PURPOSE OF WORK: (a) Preparation of volume tables for all the commercial timber species in the region; (b) the determination of reliable factors to convert one measure of timber volume into another; (c) study of growth, form, and taper of individual trees and of their principal products.
5. REVIEW OF PAST WORK: (a) Some 150 volume tables have been prepared for 24 hardwood and 8 softwood species in the Lake States and Kansas. (b) Factors for calculating the number of cubic feet per standard cord of wood have been worked out for aspen, black spruce, balsam fir, and northern hardwoods. (c) The relative bark thickness along the major portions of the stems has been determined for 18 species. (d) A generalized table showing cubic contents of tree tops and limbs (wood above the sawlog portion of the tree) has been prepared for hardwood species in the Lake States and Kansas. (e) Rules of thumb for both Scribner and International log rules have been developed. (f) Woods and mill cull percentages have been worked out for each of the important timber species in the Lake States. (g) Shrinkage and settling in the cordwood piles and the amount of cull were obtained for jack pine on the Superior National Forest.
6. ACCOMPLISHMENTS DURING PAST YEAR: A jack pine taper table has been prepared on the basis of 655 tree measurements obtained throughout the Lake States. By means of this table it is possible to determine how many logs or bolts of different diameters can be cut under any utilization practice from trees of various sizes, and to scale the different parts of the tree in different units of volume.
7. PLANS FOR NEXT YEAR: Taper tables and volume tables according to the character of product will be prepared for aspen and northern hardwoods. Such tables will be invaluable for estimating volume of cull sections, long butts, and other waste sections of the stem below the top log, and in estimating volume by log grades.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: S. R. Gevorkiantz and Staff.

January 1939

STATISTICAL METHODS

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Mensuration.
3. LINE PROJECT: Statistical Methods.
4. PURPOSE OF WORK: (a) To develop statistical methods applicable to the solution of forest problems, (b) to increase the efficiency of experimentation through improved designs, and (c) to provide valid procedures for problems involving sampling.
5. REVIEW OF PAST WORK: (a) The reliability of the Forest Survey procedure in determining the areas and volumes of forest types has been analyzed statistically. (b) Analyses have been made on a large number of plantation survival counts as a basis for making similar surveys in the future. (c) Designs were developed for several tests of planting, fertilizers, other nursery experiments, and drought resistance. (d) The results of the Forest Products Laboratory's seed extraction tests were analyzed by the Station and several new experiments designed.
6. ACCOMPLISHMENTS DURING PAST YEAR: A number of experiments have been designed and their results analyzed. These include: (a) tests of the effect of cold storage on planting stock, (b) an experiment on the effect of varying amounts of phosphorus and nitrogen on drought resistance, and (c) a plan of sampling to determine the effect of shelterbelts on grain yields.

A manual on timber cruising has been completed.
7. PLANS FOR NEXT YEAR: The various current projects at the Station will be subjected to statistical analysis. All new experiments will be designed in the light of the best available statistical knowledge. It is also planned to make a statistical study of sampling techniques for the purpose of determining more reliable and convenient methods of estimating timber on small hardwood tracts. Such a study is being prompted by the increased emphasis which has recently been placed upon the need for farm forestry and by the fact that timber inventories are basic to any wood-lot management.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: S. R. Gevorkiantz, R. H. Blythe, Jr., and Staff.

Fp-2 (Includes former Fp-1
and G-1 projects)

PLANTING

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Regeneration.
3. LINE PROJECT: Planting.
4. PURPOSE OF WORK: To develop sound reforestation practice in Lake States.
5. REVIEW OF PAST WORK: (a) Direct seeding annually since 1926. (b) Planting since 1931 on Huron National Forest, since 1934 near Roscommon, since 1936 on Manistee Forest, and since 1937 on Nicolet and Chequamegon Forests. (c) Conversion planting in aspen and brushlands begun on Chippewa National Forest in 1926 and on Superior Forest in 1932. (d) Field seed-source tests of red pine, Scotch pine, white spruce, Norway spruce, and green ash begun in 1931. (e) Plantation surveys throughout region begun in 1924.

These past studies brought out the superiority of transplants over seedlings, and spring over fall planting, the ill effects of slit planting, the inadequacy of direct seeding, differences due to seed source, and the feasibility of converting aspen and brushland to conifers.

6. ACCOMPLISHMENTS DURING PAST YEAR: The experiments have shown conclusively that (a) transplant red and Scotch pines have superior growth and survival; (b) the depth of root placement in wedge planting influences survival; (c) roots of planted conifers grow chiefly downward during the first year and laterally during the second year after planting; (d) successful hardwood planting and direct seeding of red oak are possible. The Station also developed methods of stabilizing large sand blows by planting and mechanical means and, in cooperation with the Forest Supervisor, adapted heavy machinery for large-scale planting on aspen and brushlands.
7. PLANS FOR NEXT YEAR: (a) All present planting tests on national forests will be continued. (b) Further improvement and adaptation of heavy machinery to large-scale reforestation of brush and aspen lands. (c) Manuscript on reforestation practice in region now in preparation will be finished. (d) Rough draft of manuscript on conversion practice will be put in final shape for publication.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: P. O. Rudolf, J. H. Stoeckeler, H. L. Shirley, F. H. Eyre, and R. K. LeBarron, in cooperation with Supervisors of Huron, Manistee, Nicolet, Chippewa, and Superior National Forests.

January 1939

FOREST PLANTING (NORTHERN PLAINS)

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Regeneration.
3. LINE PROJECT: Forest Planting (Northern Plains).
4. PURPOSE OF WORK: To determine the feasibility of large-scale forestation and revegetation in sandy land in the northern plains submarginal for agriculture and subject to wind erosion.
5. REVIEW OF PAST WORK: About 250 acres have been planted with various species of trees since the spring of 1931 at the Denbigh (N. Dak.) Branch Station. Careful ground preparation and continual cultivation in early years of establishment are necessary. Cottonwood, green ash, ponderosa pine, and eastern and western red cedar have proven most successful. Vegetative quadrats show that complete protection from livestock is needed in unstable dune sand areas. Past results have proven that minimum size of allowable coniferous planting stock is 2-2 transplants. Source of seed is especially important since only seedlings of northern origin have survived the rigorous winters of this region.
6. ACCOMPLISHMENTS DURING PAST YEAR: For faster growth, better survivals, and early establishment of plantations, competing "sod" vegetation must be eliminated if trees are to succeed. Tree plantings on wind-eroded sandy areas are commencing to stabilize soil where other attempts at revegetation (seeding of grasses and moving in of sod) failed.

Shelterbelt plantings in regions of heavy soils and limited rainfall proved successful in first year, with special types of ground preparation (ridging between tree rows, terraces, and pit plantings on hillsides--Minot, North Dakota, and Miller, South Dakota).
7. PLANS FOR NEXT YEAR: Further field planting tests of 80 to 100 acres will be made of new solid plantings of Juniperus scopulorum, ponderosa pine, and cottonwood. In addition, cottonwood plantations of three to five rows are to be established at 100- to 400-foot intervals. After cottonwood plantings have attained a height of 20 or more feet, intervening, wind-protected areas will be plowed and planted to conifers. Revegetation of wind-eroded fields and pastures and underplanting of aspen areas.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: J. H. Stoeckeler.

SEED STUDIES

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Regeneration.
3. LINE PROJECT: Seed Studies.
4. PURPOSE OF WORK: To discover and assemble accurate information on all characteristics of forest tree seed that intimately affect their collection and use, chiefly in reforestation operations.
5. REVIEW OF PAST WORK: (a) In cooperation with the Forest Products Laboratory, worked out satisfactory kiln schedules for white pine, red pine, and jack pine cones, and tentative schedules for white spruce and black spruce. (b) Developed successful methods for storing seed of red pine and white pine. Also found that unopened jack pine cones on trees for 15 years contain viable seed. (c) Determined satisfactory pretreatments which hasten and increase germination for white pine, tamarack, coffee tree, chittam wood, and soapberry. (d) Made routine germination and purity tests on 2,770 seed samples, covering about 150 species, submitted by public and private nurserymen in Lake States and the prairie-plains region.
6. ACCOMPLISHMENTS DURING PAST YEAR: (a) Collected for testing about 350 seed samples, representing 150 species of native trees and shrubs largely new to nursery practice. (b) Made germination tests on 150 of these samples and on 350 others submitted by nurserymen in Region 9. (c) Germinable rose seed were recovered from grouse droppings. (d) Satisfactory methods of pretreatment worked out for red gum, redbud, and tentative methods for red maple, slippery elm, white mulberry, black raspberry, and gooseberry. (e) Improved storage methods discovered for Chinese elm and cottonwood. (f) Sample illustrating proposed format of seed manual submitted Washington for approval.
7. PLANS FOR NEXT YEAR: (a) Attempt to determine cause of large percentage of nonviable seed now sown in Forest Service nurseries. (b) Make studies of little known species needed to round out the seed manual, and complete the manual. (c) Make storage tests on seed of various species, including white pine seed stored for 10 years. (d) Pretreatment to improve germination will be tested for some species which as yet give only fair results. (e) Build up the Station's collection of authoritative seed samples. (f) Determine, in cooperation with the University of Minnesota, if birds play any part in preparing refractory seed for germination.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: H. L. Shirley and E. I. Roe.

January 1939

NURSERY (LAKE STATES)

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Regeneration.
3. LINE PROJECT: Nursery (Lake States).
4. PURPOSE OF WORK: To develop nursery practices for growing the best stock for field planting.
5. REVIEW OF PAST WORK: Laboratory tests of drought resistance begun in 1932. Comprehensive nursery study begun in 1937. Principal findings have been: (a) fertilizer treatments at end of first year showed appreciable effect only on jack pine; (b) more drought-hardy stock produced by avoiding excessive watering; (c) green ash seedlings of northern origin showed greater drought resistance than those of southern origin; (d) seedlings grown in soils low in available phosphorus showed heavy overwinter loss.
6. ACCOMPLISHMENTS DURING PAST YEAR: (a) On basis of size of stock and drought resistance, fertilization practices must be determined by analysis of soil, with particular emphasis on total nitrogen and available phosphorus and potash. (b) In pot tests, superphosphate increased drought resistance while heavy doses of readily available nitrogen reduced it. (c) Low densities of sowing (40 to 60 per square foot of seedbed) appear to produce best planting stock. (d) Root pruning 3-0 white pine in spring of third year resulted in better field survival. (e) Thirty moisture meters, based on tensiometer principle, were built and used in some 15 nurseries in Region 9 and one in northern plains. (f) Proper regulation of moisture during the hardening-off period resulted in more drought-resistant stock; heavy watering resulted in production of topheavy 2-0 jack pine. (g) Poorer 20 to 30 percent of 2-0 red pine in average nursery does not survive or grow well in field and should be culled. (h) Cold storage of white spruce for 35 days at 50° F. reduced field survival from 99 to 81 percent, but jack, red, and white pine not seriously affected.
7. PLANS FOR NEXT YEAR: (a) Follow-up of nursery stock into field to determine effects of various nursery treatments on field survival. (b) Reseed some fertility plots to study carry-over effect of fertilizers on second crop of trees. (c) Continue nursery and pot tests of drought resistance as affected by nitrogen, phosphorus, and potash.
8. DATE OF COMPLETION: Nursery end of several studies will be completed by fall 1939. Field experiments if carried only for three years will be completed in fall 1942.
9. ASSIGNMENT: J. H. Stoeckeler, P. O. Rudolf, and H. L. Shirley

January 1939

NURSERY (NORTHERN PLAINS)

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Regeneration.
3. LINE PROJECT: Nursery (Northern Plains).
4. PURPOSE OF WORK: To determine how to grow best possible planting stock for forestation of sandy submarginal lands and for shelter-belt plantings in the northern plains.
5. REVIEW OF PAST WORK: An experimental nursery, $1\frac{1}{2}$ acres in size, is maintained near Denbigh, North Dakota, and additional nursery studies are being made at Towner Nursery, Towner, North Dakota. Alkalinity of soil, which is a major detrimental factor for the growing of coniferous stock, can be remedied by treatment of soil with $\frac{1}{2}$ ounce sulphuric acid per square foot or $1\frac{1}{2}$ ounces aluminum sulphate per square foot. Best production of conifers has been attained by burlap mulching, shallow seeding, and low density of sowing. Snow fence laid on 6-inch bedboards has proven the best overwinter protection, with straw the next best in coniferous beds.
6. ACCOMPLISHMENTS DURING PAST YEAR: Fertilizer experiments show that seedlings increase in growth and vigor when sheep manure (nitrogen plus organic matter) and phosphorus are added to soil. New species (Larix koreensis and Larix sibirica) which give promise of future success in field plantings are being tested. Best method of germinating Juniperus scopulorum is to depulp and clean seed, stratify in spring in wet sand at 40° F., then sow following fall.
7. PLANS FOR NEXT YEAR: An attempt will be made to introduce mycorrhizae in the nursery through peat cultures and by moving in nursery soils in which mycorrhizae already exist, because past efforts in using boiled wheat as a carrier have failed. Follow-up of fertility experiments on both hardwood and conifers, and additional acidification studies, are planned.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: J. H. Stoeckeler.

RS-LS
Pf-1 (formerly Pf-4)
Control

January 1939

FIRE CONTROL (STATISTICS)

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Forest Fire Protection.
3. LINE PROJECT: Control.
4. PURPOSE OF WORK: To provide the statistical data needed for fire control planning; to make available the results of past experience; and to show the progress and development of forest fire control in the Lake States.
5. REVIEW OF PAST WORK: Available fire statistics for Minnesota and Michigan, through 1925 and 1927 respectively, compiled and analyzed. Results published as state bulletins. Michigan statistics revised and brought up to date in 1936 and 1937. Summary and analysis of current Lake States fire statistics made and issued annually.
6. ACCOMPLISHMENTS DURING PAST YEAR: Analysis of Michigan fire data through 1935 completed. Rough draft of revised report prepared.
7. PLANS FOR NEXT YEAR: Revised report on forest fires in Michigan to be completed and issued as a Station publication. Current Lake States fire statistics to be summarized annually as in the past. Minnesota forest fire bulletin to be revised and a similar study made in Wisconsin when funds and personnel are available.
8. DATE OF COMPLETION: Michigan study--1939; Minnesota and Wisconsin studies--indefinite; annual summaries--continuing.
9. ASSIGNMENT: J. A. Mitchell.

January 1939

FIRE BEHAVIOR

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Forest Fire Protection.
3. LINE PROJECT: Behavior.
4. PURPOSE OF WORK: To determine the relationship of forest fire occurrence, behavior, and resistance to control, to weather, fuel, and cover conditions, as a basis for rating fire danger, protection planning, and the improvement of fire control technique.
5. REVIEW OF PAST WORK: Study of the factors affecting fire behavior begun in Wisconsin in 1927, was continued in Lower Michigan through 1936, and on the Nicolet National Forest during 1937 and 1938. In 1937 a study of rate of spread and resistance to control by fuel types was undertaken at the request of the Regional Office. Since 1936 also the Station has cooperated with the Regional Office in the establishment and inspection of danger stations and in analyzing the records secured.
6. ACCOMPLISHMENTS DURING PAST YEAR: Briefly stated, the major accomplishments of the past year are: (a) the development of workable danger meters for both the Lake and Central States; (b) the establishment of rate-of-spread and resistance-to-control classes for Region 9; (c) determination of the mean rate of spread and resistance to control of the more common fuel types; (d) development of formulae for use in protection planning; (e) preparation of a table giving the mean strength of attack required under given conditions to meet Region 9 control standards.
7. PLANS FOR NEXT YEAR: (a) Refinement of Lake and Central States danger meters. (b) Continuation of the study of effect of cover conditions on fire danger. (c) Completion of the rate-of-spread and resistance-to-control study. (d) Correlation of past fire weather records. (e) Continued cooperation with the Regional Office in development of danger stations and training of fire weather observers.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: J. A. Mitchell.

FIRE EFFECTS

1. FIELD DIVISION: Forest Management Research.
2. WORK PROJECT: Forest Fire Protection.
3. LINE PROJECT: Effects.
4. PURPOSE OF WORK: To determine (a) the direct and indirect effect of forest fires under specific conditions, and (b) the average damage resulting under typical conditions.
5. REVIEW OF PAST WORK: Fifteen permanent sample plots burned over under known conditions under observation. A Region-wide study of fire damage in jack pine stands completed and a similar study in northern hardwoods started.
6. ACCOMPLISHMENTS DURING PAST YEAR: Permanent sample plots reexamined and photographed. Tables prepared for state and Forest Service use in damage appraisal, giving by forest type, size class, density of stocking, and percent killed, the normal loss per acre resulting from forest fires in second-growth stands. No work done on hardwood damage study due to lack of funds and personnel.
7. PLANS FOR NEXT YEAR: If funds are available, work on hardwood damage study will be resumed and a plan made for a comprehensive study of the silvicultural effects of forest fires.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: J. A. Mitchell.

FOREST SURVEY

1. FIELD DIVISION: Forest Survey.
2. WORK PROJECT: Inventory of Resources.
3. LINE PROJECT: Inventory, Growth, and Depletion Survey.
4. PURPOSE OF WORK: To determine the area, volume, growth, and depletion of forests in the Lake States, South Dakota, and Kansas. The survey has three distinct phases: (1) collection and compilation of data, and preparation of maps, (2) interpretation and analysis of results, and (3) keeping up to date.
5. REVIEW OF PAST WORK: Field work was started in October 1933. Minnesota was covered with strip surveys during 1934, Michigan during 1935, and Wisconsin during 1936. South Dakota woodlands were sampled in 1935 and Kansas in 1937. A complete canvass was made of wood-using industries and special studies were conducted where necessary to complete the estimate of current depletion. Special crews were employed to estimate growth. A final report for South Dakota and seven preliminary releases for the Lake States were issued prior to 1938.
6. ACCOMPLISHMENTS DURING PAST YEAR: Field work was completed early in 1938 and practically all the ordinary computing was done before December 31. Some work remains to be done on maps. Final reports were drafted for Kansas and Minnesota and three additional progress reports were prepared, two of which have been issued in multilith form. The status of the work is about as follows:

State	Forest area	Percent completed		
		Collection of data	Analysis	Total
	<u>M acres</u>			
Minnesota.....	19,615	100	78	93
Wisconsin.....	16,946	93	37	76
Michigan.....	19,073	99	37	80
South Dakota..	1,709	100	100	100
Kansas.....	1,238	100	100	100
Total.....	58,581	98	54	85

7. PLANS FOR NEXT YEAR: Complete the reports for Wisconsin and Michigan and a regional report for the Lake States. Also to prepare at least three supplemental releases in the following order: (1) The Forest Situation in the Upper Peninsula of Michigan, (2) Forest Industries in the Lake States, and (3) Growth and Yield of Forest Lands in the Lake States.
8. DATE OF COMPLETION: The first two phases should be completed in the fiscal year 1940. Keeping the data up to date will be a continuing project.
9. ASSIGNMENT: R. N. Cunningham, H. G. White, and J. A. Diemer.

INVENTORY

1. FIELD DIVISION: Forest Survey.
2. WORK PROJECT: Survey of forest resources, present and future requirements.
3. LINE PROJECT: Inventory.
4. PURPOSE OF WORK: To determine the area of forest land classified by types and condition of stands and the volume of standing merchantable timber in the States of Michigan, Wisconsin, Minnesota, South Dakota, and Kansas.
5. REVIEW OF PAST WORK: Field work in the Lake States was started in October 1933. Minnesota was surveyed during 1934, Michigan during 1935, and Wisconsin during 1936. The field work was completed in March 1937. South Dakota was surveyed in 1935, Kansas in 1936.
6. ACCOMPLISHMENTS DURING PAST YEAR: The results were presented in a multilithed pamphlet entitled "Forest Areas and Timber Volumes in the Lake States," March 1938. A manuscript containing the Kansas statistics was prepared for publication by the Kansas Agricultural Experiment Station. The South Dakota figures were issued earlier in a multigraphed release.
7. PLANS FOR NEXT YEAR: See project sheet "Interpretation, Analysis, and Preparation of Reports."
8. DATE OF COMPLETION: Completed. (See project sheet on keeping findings current.)
9. ASSIGNMENT: R. N. Cunningham, H. C. Moser, and J. A. Diemer.

GROWTH AND YIELD

1. FIELD DIVISION: Forest Survey.
2. WORK PROJECT: Survey of forest resources, present and future requirements.
3. LINE PROJECT: Growth and Yield.
4. PURPOSE OF WORK: To determine the current and probable future rate of timber growth and the productive capacity of the forest area of the Lake States.
5. REVIEW OF PAST WORK: Field work was carried on coincident with the inventory of areas and volumes and was completed about the same time--March 1937.
6. ACCOMPLISHMENTS DURING PAST YEAR: A pamphlet entitled "Methods of Predicting Growth of Forest Stands in the Forest Survey of the Lake States" was issued in April 1938. In this were included new yield tables for the important forest types in the Lake States. Preliminary estimates of regional growth were sent to Washington for inclusion in a special report for the Joint Congressional Committee. Detailed computations of current growth were completed for each survey unit and are ready for inclusion in the various survey reports.
7. PLANS FOR NEXT YEAR: Estimates are being prepared on the allowable annual cut on various areas under a plan of sustained yield. Consideration is being given not only to current growth but to the condition of the growing stock as well.
8. DATE OF COMPLETION: December 1939.
9. ASSIGNMENT: S. R. Gevorkiantz and William A. Duerr.

DEPLETION

1. FIELD DIVISION: Forest Survey.
2. WORK PROJECT: Survey of forest resources, present and future requirements.
3. LINE PROJECT: Depletion.
4. PURPOSE OF WORK: To determine the rate at which the forest is being diminished through industrial and domestic use, windfall, fire, insects, disease, etc.
5. REVIEW OF PAST WORK: A complete canvass of primary forest industries was made in the Lake States. Minnesota was covered in 1934, Michigan in 1935-36, and Wisconsin in 1937-38. Studies were made of woods operations to sample utilization and waste. Fire statistics were analyzed and available records on other damage assembled.
6. ACCOMPLISHMENTS DURING PAST YEAR: Preliminary figures on forest depletion in the Lake States were sent to Washington for inclusion in a report for the Joint Congressional Committee. Detailed depletion estimates were prepared for each forest-survey unit and are available for inclusion in survey reports.
7. PLANS FOR NEXT YEAR: A report on the forest industries of the Lake States is being prepared for multigraphing and distribution to interested parties.
8. DATE OF COMPLETION: December 1939.
9. ASSIGNMENT: H. G. White.

INTERPRETATION, ANALYSIS, AND PREPARATION OF REPORTS
(FOREST SURVEY)

1. FIELD DIVISION: Forest Survey.
2. WORK PROJECT: Survey of forest resources, present and future requirements.
3. LINE PROJECT: Interpretation, analysis, and preparation of reports.
4. PURPOSE OF WORK: This project involves compiling and writing up the forest survey findings, pointing out the relation of one phase to another, and bringing in other economic factors to serve as a basis for formulating public and private policies, principles, and plans of forest-land management.
5. REVIEW OF PAST WORK: Final analysis could not begin until all computations were completed. Hence little was done before 1938. However, nine preliminary statistical releases were prepared and a number of brief articles were printed in magazines and papers.
6. ACCOMPLISHMENTS DURING PAST YEAR: A preliminary analysis of regional conditions was worked out in cooperation with the Milwaukee Regional Office and was sent to Washington as part of a report for the Joint Congressional Committee. A draft of a report on the Minnesota situation was completed and sent around for comment. Draft was also completed of a report for the Upper Peninsula of Michigan.
7. PLANS FOR NEXT YEAR: Complete two state reports--Wisconsin and Michigan--and a summary report for the Lake States Region to embody the major findings of the forest survey and comment upon their significance.
8. DATE OF COMPLETION: December 1939.
9. ASSIGNMENT: R. N. Cunningham, H. C. Moser, and H. G. White.

KEEPING (SURVEY) FINDINGS CURRENT

1. FIELD DIVISION: Forest Survey.
2. WORK PROJECT: Survey of forest resources, present and future requirements.
3. LINE PROJECT: Keeping Findings Current.
4. PURPOSE OF WORK: To provide current up-to-date information on the forest situation. This will be done by adjusting inventory estimates periodically to account for effects of depletion and growth.
5. REVIEW OF PAST WORK: Provision has been made to collect and systematically record all available statistics on forest depletion, including census records, association records, records from individual operators, reports from public forests, etc. Steps have been taken to improve the quality of some of these. Provision has been made for remeasurement of certain survey plots for the purpose of checking growth forecasts. Complete revision of estimates may be made at 10-year intervals.
6. ACCOMPLISHMENTS DURING PAST YEAR: No revisions in survey data have yet been necessary.
7. PLANS FOR NEXT YEAR: Record all data in systematic shape so that corrections can readily be made. Develop conversion factors to translate production figures into terms of standing timber depletion.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: R. N. Cunningham, H. G. White, and J. A. Diemer.

USE OF TAX-FORFEITED LANDS

1. FIELD DIVISION: Forest Economics.
2. WORK PROJECT: New Public Domain.
3. LINE PROJECT: New Public Domain.
4. PURPOSE OF WORK: The project involves two phases: (a) the determination of the causes, extent, and distribution of tax delinquency, the type of ownership involved, the character of the delinquent lands, and the effect of tax default on maintenance of local government in the forest regions; and (b) study of the problems of converting tax-forfeited lands to productive use.
5. REVIEW OF PAST WORK: Information has been compiled periodically from county and state records and from field observations to determine the extent, location, and character of tax-delinquent lands in each state. Records of the extent, location, and use of publicly owned lands have been compiled. The effect of tax delinquency and of public ownership of forest lands on local government finance has been analyzed in selected counties. This information has been made available to various official legislative and investigative committees concerned with forest taxation, tax delinquency, and forest-land problems in the Lake States.
6. ACCOMPLISHMENTS DURING PAST YEAR: Assembled all available statistics on extent and location of large private forest holdings. Made a survey of grants-in-aid in Minnesota to determine effect on forest land use of state aids and payments in lieu of taxes on forfeited lands. Prepared a bulletin, "Idle Lands--Idle Men," for publication by the Minnesota State Planning Board. Much time spent in preparing and presenting material to Legislative Interim Commission on Forestry and Tax-Delinquent Lands in Minnesota. Prepared an analysis of local government, taxation, and state aids in northern Lake States for Northern Lake States Regional Committee.
7. PLANS FOR NEXT YEAR: With the completion of work on the report of the Minnesota Interim Commission on Tax-Delinquent Lands, it is felt that studies of the causes and financial consequences of tax delinquency and of the extent of delinquency have been substantially completed. In 1939 study will be concentrated on problems of organizing forfeited and other public lands into self-sustaining units as a means of increasing the contribution of forests to local employment and community support.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: H. C. Moser.

FARM WOODLAND STUDY

1. FIELD DIVISION: Forest Economics.
2. WORK PROJECT: Private Forestry.
3. LINE PROJECT: Farm Woodlands.
4. PURPOSE OF WORK: To study economic organization in relation to increasing yields, income, and rural social benefits to persons dependent on farm woodlands and other small holdings.
5. REVIEW OF PAST WORK: Preliminary case studies, begun in 1937, have been made in five typical woodland areas throughout the region.
6. ACCOMPLISHMENTS DURING PAST YEAR: Completion of studies and analysis of the farm-forest situation in seven typical woodland areas in the region: (1) the Yuba maple-basswood area in southwestern Wisconsin, (2) the northern-hardwood area of Antrim County, Michigan, (3) the forest-products marketing district around Cloquet, Minnesota, (4) the Littlefork working circle in northern Minnesota, (5) the oak-hickory area of La Crosse County, southwestern Wisconsin, (6) the quality-hardwood area of Eaton County, in the southern lower peninsula of Michigan, and (7) Carver County, Minnesota, an intensive-farming section.
7. PLANS FOR NEXT YEAR: To prepare a regional report, summarizing and analyzing the results of the preliminary case studies. To continue work on the specific problems of timber utilization, marketing of forest products, and costs and returns from the practice of forestry by small owners. (Emphasis will be placed on the woodlands of the northern cutover region.) To prepare a handbook of forest practice and timber cruising, grading, utilization, and marketing applicable to small timber holdings in the region.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: Raphael Zon, R. N. Cunningham, William A. Duerr, and Carl J. Holcomb.

EROSION AND RUNOFF STUDIES

1. FIELD DIVISION: Forest Influences.
2. WORK PROJECT: Stabilization of Soils.
3. LINE PROJECT: Relation of forests to erosion and runoff.
4. PURPOSE OF WORK: Study of factors influencing soil wastage and streamflow in the unglaciated area of southwestern Wisconsin and adjacent Minnesota, Iowa, and Illinois, with special emphasis upon the capacity of forests to ameliorate destructive runoff and erosion.
5. REVIEW OF PAST WORK: Work on this project conducted chiefly at Upper Mississippi Valley Erosion Station near La Crosse, Wisconsin, in cooperation with Soil Conservation Service and University of Wisconsin. (a) Records of surface runoff and soil loss have been taken since 1932 on three watersheds, one timbered and ungrazed, one timbered and grazed, and one cleared and grazed. (b) In 1933 constructed 10 concrete, tar-lined lysimeters which were filled with soil and different surface covers established. Observations on total precipitation, surface runoff, percolation, and soil loss maintained since establishment of cover conditions.
6. ACCOMPLISHMENTS DURING PAST YEAR: Although approximately 41 inches of precipitation were recorded at the La Crosse Station during the past 12 months, not one drop of this rain or melting snow was recorded as surface runoff from the ungrazed, forested watershed. The loss from a grazed, wooded pasture amounted to 0.784 inch; from a moderately grazed pasture, 0.178 inch.

Tree-covered lysimeters continued to yield less runoff and more ground water (percolate) than tanks planted with any other kind of vegetation. Unlike previous years, two bluegrass plots yielded considerable percolate. Excessive late summer and early fall rains undoubtedly were responsible for this reversal of past trends.
7. PLANS FOR NEXT YEAR: The watershed and lysimeter studies will be continued at La Crosse.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: H. F. Scholz and C. G. Bates.

SHELTERBELTS

1. FIELD DIVISION: Forest Influences.
2. WORK PROJECT: Effect of Cover on Climate.
3. LINE PROJECT: Shelterbelts.
4. PURPOSE OF WORK: To determine the relative effectiveness of shelterbelts of different design and arrangement in ameliorating climate in the immediate vicinity.
5. REVIEW OF PAST WORK: Most of the work on this project, including wind and evaporation measurements as a means of defining wind-break efficiency, a study of radiation, some measurements of crop yields, and measurements of effect of wind reduction on soil moisture, was done in the years 1935-37.
6. ACCOMPLISHMENTS DURING PAST YEAR: The field measurements of wind-break efficiency by means of anemometers were carried on until September, when the work was shut down. Evaporation studies at Miller, South Dakota, and at the Denbigh branch station were also continued to about the same time. Measurements on about ten fields of small grain and fifty in corn were made in Kansas, Nebraska, South Dakota, and North Dakota, each field being protected on at least one side by a shelterbelt. Results in a majority of cases showed some positive benefit to crops. The SCS cooperated in the corn study.
7. PLANS FOR NEXT YEAR: Except for a continuation of the crop measurements with the cooperation of other agricultural agencies, little field work is contemplated. Every effort will be devoted toward summarizing the results already obtained, especially the primary study showing how wind velocities are affected by barriers of various kinds.
8. DATE OF COMPLETION: Except for crop measurements which should be continued over a series of years, 1940 should see the completion of current studies.
9. ASSIGNMENT: C. G. Bates, W. E. Barnes, E. J. Dortignac, and J. W. Macon.

PRELIMINARY WATERSHED EXAMINATIONS

1. FIELD DIVISION: Flood Control Surveys.
2. WORK PROJECT: Flood Control Surveys.
3. LINE PROJECT: Preliminary Examinations.
4. PURPOSE OF WORK: Examination of watersheds to determine the existence of flood problems.
5. REVIEW OF PAST WORK: Report on the St. Croix completed.
6. ACCOMPLISHMENTS DURING PAST YEAR: The following preliminary examination reports were completed during the year: Kickapoo, Saginaw, Whitewater, Zumbro, and Souris. Detailed watershed surveys were recommended for the Kickapoo, Whitewater, and Zumbro watersheds.

Hydrologic data has been compiled and silt sampling work carried out on a number of other streams.

The Station is represented on a committee to consider a complete revision of the Upper Headwaters of the Mississippi section of the Drainage Basin Report. The Station has submitted a revision embodying a more complete and better integrated water plan for the whole area than has been formerly presented.

7. PLANS FOR NEXT YEAR: Preliminary reports will be prepared for other streams as rapidly as facilities permit.
8. DATE OF COMPLETION: Indefinite.
9. ASSIGNMENT: C. G. Bates, R. H. Blythe, Jr., and Raphael Zon.

WATERSHED SURVEYS

1. FIELD DIVISION: Flood Control Surveys.
2. WORK PROJECT: Flood Control Surveys.
3. LINE PROJECT: Watershed Surveys.
4. PURPOSE OF WORK: To make detailed surveys of approved watersheds for preparing action programs.
5. REVIEW OF PAST WORK: Work begun on the Kickapoo watershed in August 1938.
6. ACCOMPLISHMENTS OF PAST YEAR: Detailed survey of the Kickapoo was begun in August, and a large part of the field work has been completed. This consisted in the examination of sample farms for which maps were already available through the CCC and AAA. Plans were then outlined on the ground for the changes required to put these sample farms in good condition for watershed protection, as an indication of what needs to be done on the entire watershed.

Silt sampling and stream gaging have also been done on a large number of the Kickapoo tributaries.
7. PLANS FOR NEXT YEAR: Other surveys will be undertaken when approved. The areas of first priority now are the Whitewater and Zumbro watersheds which are under the chairmanship of the SCS.
8. DATE OF COMPLETION: July 1, 1939, for the Kickapoo.
9. ASSIGNMENT: C. G. Bates, H. F. Scholz, R. H. Blythe, Jr., and J. W. Macon.